DOCUMENT RESUME

ED 349 170 SE 052 994

AUTHOR Niess, Margaret L.; Erickson, Dianne K.
TITLE The Oregon Mathematics Teachers of Middle School Mathematics Project. A Curriculum Development and Leader Training Project for Middle School Teachers of Mathematics. Final Report.
INSTITUTION Oregon State Univ., Corvallis. Coll. of Science.
SPONS AGENCY Department of Education, Washington, DC.
PUB DATE Mar 92
CONTRACT R168D90164
NOTE 91p.
PUB TYPE Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Analysis of Covariance; *Change Agents; Curriculum Development; Educational Change; Educational Strategies; *Inservice Teacher Education; *Instructional Innovation; Instructional Materials; Intermediate Grades; Junior High Schools; Lesson Plans; *Mathematics Achievement; *Mathematics Curriculum; Mathematics Education; *Mathematics Instruction; Middle Schools; Multivariate Analysis; Staff Development; Student Attitudes; Teacher Attitudes; Teaching Methods
IDENTIFIERS NCTM Curriculum and Evaluation Standards; *NCTM Professional Standards for Teaching Math; Oregon

ABSTRACT

This document reports the results of The Oregon Mathematics Teachers of Middle School (TOMTOMS) project focused on improving the curriculum and the teaching of mathematics in middle school in support of recent calls for mathematics education reform. Twenty seventh-grade teachers, representing the geographic regions in Oregon, were chosen from a statewide pool of applicants to participate in the TOMTOMS project. The TOMTOMS program, divided over two summers, consisted of course work designed to increase the teachers' knowledge and skills in mathematics, curriculum design, curriculum implementation, leadership skills, teaching methods, and alternative assessment strategies. Following participation, data was collected on student achievement, students' beliefs and attitudes, teacher demographics, availability of curriculum materials, and teacher implementation of the curriculum reforms via a coded planning schedule called "the calendar." Seventeen of the 21 teachers who completed the project and used TOMTOMS teaching materials and their 289 students were subsequently compared to a control group of 13 seventh-grade teachers who used traditional text materials and their 200 students on students' achievement, as well as their beliefs and attitudes. Correlations of TOMTOMS teachers' use of new activities and teacher questionnaire responses with residual gains in students' achievement and students' attitudes and beliefs were also presented and discussed. Achievement test results analyzed using ANCOVA with the pretest as the covariate revealed no differences. MANCOVA analysis compared TOMTOMS class attitudes/beliefs with those of the control classes, using the fall scores as the covariate, and revealed no significant differences. Appendix titles include: (1) Symposium Agenda; (2) Student Achievement Test; (3) Student Questionnaire; (4) Teacher Instructions and Teacher Calendar; and (5) Teacher Questionnaire. (30 references) (MDH)

ED349170

The Oregon Mathematics Teachers of Middle School Mathematics Project

A Curriculum Development and Leader Training Project for Middle School Teachers of Mathematics

Final Report to the U.S. Department of Education

Grant # R168D90164

Report submitted: March, 1992

SE052994

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THE OREGON MATH TEACHERS OF MIDDLE SCHOOL PROJECT

Mathematics materials developed under a grant from the U. S. Department of Education, Project R168D90164, Oregon State University, September, 1991

Project Directors

Dr. Margaret L. Niess Dr. Dianne K. Erickson

Science and Mathematics Education
College of Science
Oregon State University
Corvallis, Oregon 97331
(503) 737-4031

Lead Teachers

Cathy Brown
J. B. Thomas Jr. High School
Hillsboro, Oregon

Joan Miller
Fernwood Middle School
Portland, Oregon

Jim Specht
Bolton Middle School
West Linn, Oregon

Kris Warloe
Cheldelin Middle School
Corvallis, Oregon

Joanne Wilkie
Sellwood Middle School
Portland, Oregon

Graduate Assistants

Linda Bolich

Martha VanCleave

Editors and Typists

Susan Barton
Kristi Moore

Bill Holtzinger
Trisha Morrell

Participant Teachers and Participating Schools

Lory Bechtold
Alpine Elementary School
Alpine, Oregon

Jolene Benvegar
Philomath Middle School
Philomath, Oregon

Lucy Bisio
Taft Middle School
Lincoln City, Oregon

Cathy Brown
J. B. Thomas Jr. High School
Hillsboro, Oregon

George Fox
South Middle School
Grants Pass, Oregon

John Friday
Cheldelin Middle School
Corvallis, Oregon

Jane Fuller
Tom McCall Middle School
Forest Grove, Oregon

Sue Gonor
Walker Middle School
Salem, Oregon

Teresa Ketelsen
Calapooia Middle School
Albany, Oregon

Bill Kinkley
Memorial Middle School
Albany, Oregon

Lizy Madathil
Cal Young Middle School
Eugene, Oregon

Shelley Martin
Mt. View Intermediate School
Beaverton, Oregon

Brent McClain
Mt. View Intermediate School
Beaverton, Oregon

Marge McDowell
Cacade Jr. High School
Turner, Oregon

Karen Moloney
Fernwood Middle School
Portland, Oregon

James Reger
Armand Larive Jr. High School
Hermiston, Oregon

Russ Sanders
Dickey Prarie Elementary School
Molalla, Oregon

Mina Uhl
Ockley Green Middle School
Portland, Oregon

Mary Young
Lacomb Elememtary School
Lacomb, Oregon

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Introduction

Nationally, leaders in mathematics education (National Council of Teachers of Mathematics, NCTM) call for new standards in the mathematics curriculum as well as in teaching mathematics. Inherent in the demand for change is a consensus that all students needs to learn more, and often different, mathematics and that instruction must be significantly revised. Also, inherent in the demand is a call for connections in the curriculum, emphasis on the interrelatedness of the disciplines and the relationship of the disciplines in solving real world problems. As indicated in Professional Standards for Teaching Mathematics (hereafter referred to as Teaching Standards) the instruction in mathematics must shift:

- toward a comprehensive education for every student;
- toward classrooms as communities;
- toward conjecturing, inventing, and problem solving;
- toward connecting mathematics, its ideas, and its applications;
- away from the teacher as sole authority for right answers;
- away from mechanistic answer-finding. (p 3-4)

The kind of teaching envisioned in the new standards is significantly different than that which most teachers have experienced as students themselves. As noted in the Teaching Standards, "teachers need time to learn and develop this kind of teaching ... Good instructional and assessment materials and the latitude to use them flexibly are keys to the process of change" (p. 3).

Middle School Mathematics

Within the call for change in the mathematics curriculum, particular recognition is given to the need for re-evaluation of the middle school mathematics curriculum and the teaching of that curriculum (Everybody Counts,

1989; Curriculum and Evaluation Standards, 1989; Professional Standards for Teaching Mathematics, 1991). A close look at the current middle school mathematics curriculum reveals a traditional curriculum focused on algorithmic skills emphasized by drill and practice with little connection to real world applications. The newer vision for the middle school curriculum is a broad, concept-driven curriculum, one that reflects the full breadth of relevant mathematics and its interrelationships with technology. According to NCTM's Curriculum and Evaluation Standards (hereafter referred to as Curriculum Standards

> an ideal middle school mathematics curriculum would expand students' knowledge of numbers, computation, estimation, measurement, geometry, statistics, probability, patterns and functions, and the fundamental concepts of algebra. (p. 65-66)

Yet,

> an examination of textbook series shows the repetition of topics, approach, and level or presentation in grade after grade. (p. 66)

Much has been written about the need but, little change is evident. In 1978, Welch described mathematics classes in National Science Foundation (NSF) case studies:

> In all math classes that I visited, the sequence of activities was the same. First, answers were given for the previous day's assignment. The more difficult problems were worked on by the teacher or the students at the chalkboard. A brief explanation, sometimes none at all, was given of the new material, and the problems assigned for the next day. The remainder of the class was devoted to working on homework while the teacher moved around the room answering questions. The most

> noticeable thing about math classes was the repetition of this routine. (p. 6)

After more than ten years of intense discussions about the mathematics curriculum, of calls for reform, of development of new mathematics materials and different instructional strategies, the routine in the mathematics classrooms is relatively unchanged from Welch's description.

Mathematics at the middle grades is even more problematic than at either elementary or high school (Flanders, 1987; Steen, 1986). For these grades there is no history of clear mathematical mission (Lappan & Mundy, 1991). Emotional, social, physical and cognitive changes impact the instruction in the middle grades. The repetitious, sedentary routine of the typical mathematics classroom simply does not meet the needs of this group of students, providing little stimulation or challenge for the majority. Furthermore, evidence indicates the widespread calls for use of manipulatives (Sowell, 1989), small groups (Webb, 1982), cooperative groups, problem-oriented approaches and technology (Romberg & Carpenter, 1986), have not translated into practice in the middle school mathematics classroom (Dossey et al., 1986; McKnight et al., 1987; Nelson et al., 1990).

Teacher Change and Middle School Mathematics

What is involved in bringing about substantial and recurring change as called for in the nationwide curriculum reform statements? Certainly, teachers are the primary change agents; they must change what they teach and how they teach it. And as indicated by Duffy and Roehler (1986):

> Getting teachers to change is difficult. They particularly resist complex, conceptual, longitudinal changes as opposed to change in management routines, or temporary changes. (p. 55)

Middle school mathematics teachers have difficulty conceiving how to actually integrate the materials, manipulatives and technologies into their classes because they have never experienced a mathematics curriculum that uses a broad umbrella of goals as its organizer rather than day-by-day objectives. And, these teachers are at the frontline of questions about the traditional curriculum; they must answer to parents and administrators about changes from state accepted guidelines. Leaders, by in large, preach to the converted. The teachers must effect the conversion.

The constructivist philosophy provides a framework for devising a plan for helping teachers make the changes as identified in the call for reform (Davis, Maher, & Noddings, 1990). This philosophy assumes that the learners (in this case the teachers) must construct their own knowledge, individually and collectively. Each teacher has "tool kit of conceptions and skills" with which to construct knowledge to solve problems (teaching different mathematics in a different manner). Teachers need time to learn and develop this kind of teaching. They need materials, but they also need to be involved in the development of the materials. They need instructional models, but they also must be involved in the forming of the instructional models. And, they need support and latitude to experiment, to try approaches, to change approaches; in other words, they need encouragement to learn, to learn new mathematics and new ways of teaching mathematics.. As indicated in NCTM's Teaching Standards, "Change is difficult and will take time and reliable, systematic support " (p 3).

Supporting evidence for this perception on teacher change is provided in the Rand Change Agent study conducted in 1973-1978. McLaughlin and Marsh (1978) described the findings aimed at changing experienced teachers' practices as needing personal involvement in addition to providing exemplary

materials. Strategies were identified that were found to be effective, especially when applied in concert:

- concrete, teacher-specific and extended training
- classroom assistance from local staff
- teacher observation of similar projects in other classrooms, schools, or districts
- regular project meetings that focused on practical issues
- teacher participation in project decisions
- local development of project materials
- principals' participation in training.

After more than 15 years, McLaughlin (1990) reexamined the findings. A finding that remained supported was that "Policy cannot mandate what matters.... Although teachers in a site may be eager to embrace a change effort, they may elect not to do so, or to participate on only a pro forma basis, because their institutional setting is not supportive" (p.12-13). On the other hand, three interpretations required revision:

- teachers' initial motivation to participate in a change agent project to predict outcomes is a significant factor in creating change;
- the role of external consultants or externally specified projects is a more positive factor in creating change; and
- the structures available to provide resources and support for teachers' professional growth are critical factors in creating change. (p 13-14)

Richardson (1990) adds that "Without an understanding of the theoretical framework and the opportunity to talk about how the premises in the theory agree or disagree with the teachers' own premises, teachers may accept or reject practices on the basis of whether they meet the personality needs of the teacher and other more ecologically created concerns such as classroom

management and content coverage " (p. 16). The researcher indicates that teachers must have opportunities to interact and have conversations around standards, theory and classroom activities if change in teacher behavior is desired.

The Project Research

The Oregon Mathematics Teachers of Middle School (TOMTOMS) project is focused on improving the curriculum and teaching of mathematics in middle school. The project examines a model for change which focuses the involvement of teachers in the development of the curriculum materials as well as a development of the instructional strategies to be used. The major question of the study is "How effective is the curriculum development-leader training model for changing the mathematics and the instruction in the middle school classroom?"

Connecting mathematics to activities that are meaningful to middle school students is the special feature of the TOMTOMS project. Applications from the real world and motivational problem solving are integrated with the use of modern technology including manipulatives, calculators, and computers. Oregon locations, geography, weather, homes, towns, history, kids, and families provide a unique problem setting for investigating mathematics. All classroom activities are developed in light of the Curriculum Standards and the Teaching Standards.

This project included research on students' mathematics achievement and attitudes, the creation of materials, and teachers' planning and use of these materials in their middle school classes.

Method

Sample

Twenty teachers, representing the geographic regions in Oregon, were chosen from a statewide pool of applicants to participate in the TOMTOMS project. The teachers were chosen based on (1) their commitment to effecting change in

mathematics teaching and curriculum, (2) a teaching assignment which included at least two seventh grade mathematics classes during 1990-91 school year and (3) the school district's support for testing new materials in the seventh grade mathematics classes. In addition, one of the members of the Leader Teacher writing team joined the participant group after completing her TOMTOMS curriculum and instructional responsibilities during the first summer.

Seventeen of the 21 teachers and 289 TOMTOMS students completed the achievement and attitude aspects of the study. Two teachers resigned from the project prior to the second summer. Student attrition rate during the school year resulted in incomplete data sets for two additional teachers. These four teachers were dropped from the research. Students included in the study completed both achievement tests and attitude questionnaires in September and post achievement tests and attitude questionnaires in May of the 1990-91 school year.

In addition, 13 teachers and 200 students in intact seventh grade classes who used traditional text materials participated in the achievement and attitude aspects of the study to provide a contrast to the TOMTOMS group.

Focusing the Project

Five leading middle school mathematics educators were chosen to form the Leadership/writing team. The assignment for this team was to develop the pilot curriculum ideas to be presented to the teacher participants during the summer session. A one-day symposium (see Appendix A) of leaders in mathematics education throughout the Pacific Northwest was held to identify a focus for the curriculum materials. Mathematical connections and problem solving were chosen as the organizaers for the materials. The Leadership/writing team then identified the theme of Back to the Future in Oregon. This theme allowed for diverse projects including history, geography, science, economics, and prediction.

The Program

The TOMTOMS program consisted of course work designed specifically to increase the teachers' knowledge and skills in mathematics, curriculum design, curriculum implementation, leadership skills, teaching methods, and alternative assessment strategies. This course work was divided into two summer sessions. During the first summer session, the teachers investigated, evaluated, and revised the pilot materials developed and presented by the Leader Teacher Writing Team. They concentrated on developing their own curriculum for the coming year and the teaching methods they planned to use. The TOMTOMS course work specifically focused on issues discussed in the Curriculum Standards. The TOMTOMS project assignments included readings and discussions on the nature of mathematics (National Research Council, 1989; Whitehead, A. M., 1958), philosophy of education (Adler, 1982; Friere, 1968; Kagan, 1988), and history of mathematics education (NCTM, 1970) as well as readings on both past and present mathematics curriculum and recommended curriculum at the middle school level (NCTM, 1989) .

TOMTOMS teachers participated in activities provided by the Leadership Team from a variety of existing sources that exemplified the Curriculum Standards. Manipulatives, calculators, computers, small groups, and discovery lessons were shared. The TOMTOMS teachers then formed cooperative groups, researched and shared materials, resources, activities, and developed a bibliography on topics and strands chosen from the Curriculum Standards. Next, the Leadership team presented the TOMTOMS materials developed particularly for Oregon middle school mathematics students emphasizing connections of mathematics to other school subjects, problem solving, and applications to the world around us. Then, TOMTOMS teachers developed a set of their own materials based on their teaching locale and, finally, cross-referenced all materials and units from the

summer with the Curriculum Standards and the Oregon Comprehensive Curriculum Goals in a data base.

The final project for this first eight-week summer was to develop a plan for their TOMTOMS seventh grade class for the 1990-91 school year. Many worked and shared in small groups, but most teachers ultimately designed their own curriculum plan to fit with their school district goals for the next year. This plan, including at least three alternative student assessment methods, was presented to the project directors during an interview session at the end of the summer.

Following this summer session, the teachers implemented their curriculum design in their own classrooms. During the TOMTOMS year, teachers translated the broad curriculum plans into units of study and daily lesson plans for their seventh grade classes based on their own personal philosophy and their school district goals. Each teacher randomly selected one class as the target class (hereafter referred to as the TOMTOMS class). Each teacher also randomly selected a comparison seventh grade class taught by another teacher (without the TOMTOMS experiences) in the same or neighboring school. Throughout the school year, TOMTOMS classes used new TOMTOMS curriculum materials and methods developed as part of this project, as well as other curriculum project materials (eg. Middle Grades Mathematics Project (MGMP), The Mathematics Curriculum and Teaching Program (MCTP), Math and the Mind's Eye, Project AIMS) and local school district curricula. Comparison classes used traditional text materials. Teacher plans, calendars (planning schedules), portfolios, teacher questionnaire data and student achievement and attitude data were collected for the TOMTOMS classes; student achievement and attitude data were also collected for the comparison classes.

During the second summer, instruction focused on materials revision and development, instructional strategies, leadership skills, and preparation for

inservicing other teachers with the TOMTOMS model. This second summer used the Teaching Standards as the focus. Teaching strategies, particularly deductive and inductive models, were exemplified by the project directors. Each TOMTOMS teacher planned and taught several lessons for peers (discovery, technology, lab). Second, the TOMTOMS materials were revised and rewritten based on recommendations from the prior school year's experience with the materials. The materials were divided into sections, each section assigned to a small group of TOMTOMS teachers. Each group made revisions and prepared the materials in a consistent format; these revisions were compiled into a single document for publication (see accompanying TOMTOMS, Oregon Trail of Mathematics). Third, TOMTOMS teachers planned a personal staff development project for their district middle school mathematics staff and a state-wide TOMTOMS conference held on teachers inservice day, Fall 1991.

Instruments

Student achievement. Student achievement was measured using an instrument developed by project staff using the Curriculum Standards and Oregon Comprehensive Curriculum Goals as guidelines (see Appendix B). The 64-point test contained three sections:

1. Section One (22 points) measured "traditional" seventh grade content, specifically concerned with computational skill.

2. Section Two (20 points) measured the student's ability to interpret and solve word problems.

3. Section Three (22 points) included one open-ended problem, one pattern exploration (including making a table, stating a rule, and graphing), and one evaluation of a given solution to a particular situation.

Validity on the achievement test was established in two ways. Three members of the Oregon Department of Education's Mathematics Assessment

Committee reviewed the test and suggested modifications. In addition, the 21 teachers in the sample reviewed the test by completing a table of specifications comparing items to the Curriculum Standards and the Oregon Comprehensive Curriculum Goals. A pilot test was conducted the summer prior to the study with students of the same age as students in the study, but who would not be in TOMTOMS classes. Reliability on the test was established at 0.75, using Cronbach alpha.

Student questionnaire. Both student demographic data and student attitudes/beliefs toward mathematics were collected through a questionnaire (see Appendix C). The attitude/ belief items were adapted from a questionnaire developed by Schoenfeld (1989). Reliability on the attitude/belief portion of the of the questionnaire was established at .84, using Cronbach alpha.

Teacher plans, calendars, portfolios, and interviews. TOMTOMS teachers made a year-long curriculum plan for their target classes during the first summer of the project and presented this plan during a one-hour interview to one of the two project directors. During the school year the teachers kept a daily, coded planning schedule referred to as the calendar (codes included type of presentation, manipulative and technology use, and purpose of the activity), and a portfolio of materials other than text materials used to teach the target class (see Appendix D). A second one-hour interview was conducted during the second summer.

Teacher questionnaires. Teacher questionnaires requested demographic data, availability of new curriculum materials other than TOMTOMS materials, availability of manipulatives and technology (see Appendix E). Additional information was solicited on amount of time available during the school year to prepare alternative activities to the text (and the need for such activities), time available to spend on problem solving and open-ended investigation, and time spent in class on large group discussions and cooperative small groups. Teachers

were asked to estimate the percent of available time spent in a typical week on development, application, problem solving, and open-ended investigation. In addition they were asked to list the number of weeks each year they spent on teaching each unit in their seventh-grade-level class.

Results

Student Results

Achievement. Achievement test results were analyzed using ANCOVA with the pretest as the covariate. Classes were used as the unit of analysis. On the 64-point achievement test, TOMTOMS' classes (n=17) averaged 14.41 on the pretest and 23.83 on the posttest and control classes (n= 13) averaged 12.73 on the pretest and 20.92 on the posttest. See Table 1 for results. No differences between TOMTOMS' and control students were found on the total test or any of the sub-sections of the test. Additional analysis considered possible achievement differences between girls and boys. No significant differences were found in three comparisons, (1) between boys and girls in the TOMTOMS classes, (2) between boys and girls in all classes, and (3) between boys and girls in TOMTOMS classes when compared with control classes.

Attitudes /beliefs. Student attitudes/beliefs about mathematics were assessed in a 25-item, Likert scale (1 = not true, 3 = neutral, and 5 = very true) questionnaire patterned after a questionnaire used by Schoenfeld (1989). Students in the TOMTOMS classes and the control classes completed the questionnaire in the fall and the spring.

A t-test was used to describe differences in TOMTOMS class results from fall to spring. Table 2 presents both the t-test results and descriptives for the TOMTOMS classes. Overall, the TOMTOMS classes' attitudes/ beliefs about mathematics were positive, with little change in that expression from fall to spring. For example, as a group, the classes strongly agreed (above a 4 out of 5 on the

Table 1

Comparison of TOMTOMS and Control Classes Achievement Using Pretest as Covariate

	TOMTOMS (N=17)				Control (N=13)					
	Pretest		Posttest		Pretest		Posttest			
Variable	M	SD	M	SD	M	SD	M	SD	F	p
Section 1	8.58	2.41	13.10	3.28	7.73	2.16	11.61	2.10	.949	.338
Section 2	3.00	1.70	5.58	2.00	2.87	1.51	4.99	2.25	.905	.350
Section 3	2.93	1.44	5.15	2.02	2.13	.76	4.43	1.06	.043	.838
Total	14.41	4.80	23.83	6.88	12.73	3.92	20.92	4.93	.625	.436

Table 2

TOMTOMS Student Attitude and Belief Differences from Fall to Spring

(On a scale of 1=not true, 3=neutral, 5=very true)

	Fall		Spring			
	Mean	SD	Mean	SD	t-value	p
Section 1						
The math that I learn in school is:						
1. Mostly facts and procedures that must be memorized.	3.40	.27	3.52	.28	.60	.55
2. A way of thinking about things.	3.34	.41	3.38	.49	-.88	.38
3. Describes the world in some way.	2.83	.41	2.91	.44	-2.08	.04*
4. Related to other subjects studied in school.	3.19	.45	3.23	.28	-.47	.64
Section 2						
5. In math the answer is either right or it is wrong.	3.99	.29	3.60	.45	6.45	.00**
6. Good math teachers let students figure out their own way of solving problems.	3.06	.30	2.90	.54	.87	.39
7. Good math teachers show students lots of ways to look at the same problem.	4.43	.27	4.44	.30	-1.36	.18
8. Good math teachers show you the exact way to answer the math problems you will be tested on.	3.50	.27	3.86	.44	-2.15	.04*

Table 2 (continued)

TOMTOMS Student Attitude and Belief Differences from Fall to Spring

(On a scale of 1=not true, 3=neutral, 5=very true)

	Fall		Spring			
	Mean	SD	Mean	SD	t-value	p
Section 3						
9. Everything about math that is important is already known by someone.	3.40	.33	3.10	.41	1.11	.28
10. In math you can sometimes figure out new ideas by yourself.	4.22	.27	3.99	.33	.09	.93
11. To solve math problems you have to be taught the right procedure, or you can't do anything.	2.98	.48	2.90	.44	1.25	.22
12. Math problems outside of math class can be solved by common sense instead of the math rules you learn in school.	3.35	.24	3.33	.45	.00	1.00
13. The best way to do well in math is to memorize the way to solve the problems.	4.06	.32	3.78	.50	3.81	.00**
14. The best way to do well in math is to use a calculator.	2.25	.39	2.45	.45	-2.41	.02**

Table 2 (continued)

TOMTOMS Student Attitude and Belief Differences from Fall to Spring

(On a scale of 1=not true, 3=neutral, 5=very true)

	Fall		Spring			
	Mean	SD	Mean	SD	t-value	p
Section 4						
15. Some people are good at math and some aren't.	4.47	.31	4.47	.27	.35	.72
16. I am naturally good at math.	3.00	.39	3.09	.34	-1.19	.24
17. Girls are naturally better at math than boys.	1.91	.39	1.87	.33	-.03	.99
18. I am good at math when I study very hard.	4.16	.34	3.93	.29	3.13	.00**
19. I get good grades when I am not careless on my math papers.	4.17	.32	4.03	.39	1.47	.15
20. I can get the answer, but not always the teacher wants.	3.75	.25	3.80	.29	-1.93	.06
21. It is important to my mother that I do well in math.	4.22	.24	4.14	.25	1.99	.05*
22. It is important to my father that I do well in math.	4.15	.27	4.21	.21	-.34	-.74

Table 2 (continued)

TOMTOMS Student Attitude and Belief Differences from Fall to Spring

(On a scale of 1=not true, 3=neutral, 5=very true)

	Fall		Spring			
	Mean	SD	Mean	SD	t-value	p
Section 5						
23. Math is a very useful subject.	4.61	.18	4.41	.28	2.37	.02
24. Math will be useful to me when I grow up.	4.55	.27	4.46	.30	1.10	.28
25. In my life I will need to know more math than I know now.	4.51	.24	4.36	.24	2.65	.01**
26. Most jobs require knowledge of mathematics beyond what I know now.	4.25	.20	4.17	.21	1.17	.25
27. Math is only important for people who want to be scientists or engineers.	1.64	.43	1.70	.41	-.36	.72
28. My parents use math.	4.57	.24	4.46	.20	1.55	.13

* $p < .05$. ** $p < .01$.

Likert scale) with the statements that good math teachers show students lots of ways to look at the same problem, in math you can sometimes figure out new ideas by yourself, I am good at math when I study very hard, it is important to my mother and father that I do well in math, my parents use math, math is a very useful subject, math will be useful to me when I grow up, in my life I will need to know more math than I know now, and most jobs require knowledge of mathematics beyond what I know now. The group was neutral (about 3 out of 5) about the following statements: good math teachers let students figure out their own way of solving problems and I am naturally good at math. The TOMTOMS group felt negatively (less than 3) about the following statements: math describes the world in some way; to solve math problems you have to be taught the right procedure, or you can't do anything; the best way to do well in math is to use a calculator; girls are naturally better at math than boys; and math is only important for people who want to be scientists or engineers.

According to the t-test results, the TOMTOMS classes felt significantly more strongly in the spring than in the fall that the math they learn in school describes the world in some way, that good math teachers show you the exact way to answer the math problems you will be tested on, and the best way to do well in math is to use a calculator. They felt significantly less strongly in the spring than in the fall that in math the answer is either right or it is wrong, the best way to do well in math is to memorize the way to solve the problems, I am good at math when I study very hard, that it is important to my mother that I do well in math, and in my life I will need to know more math than I know now.

MANCOVA analysis compared TOMTOMS class attitudes/ beliefs with those of the control classes, using the fall scores as the covariate. No significant differences were found for the questionnaire. No gender differences were found when comparing boys to girls in all classes.

Teacher Data

TOMTOMS teachers averaged 10.4 years teaching experience (ranging from 2 years to 30 years) and 6.9 years experience at the middle school level. Two teachers held elementary teaching certificates, seven teachers held elementary teaching certificates with mathematics endorsements, three teachers held middle school mathematics certificates, and seven teachers held secondary school mathematics certificates.

Teacher calendars. Table 3 displays the mean number of times that TOMTOMS teachers identified each category in their teaching calendars. These teachers used an average of 242.7 specific activities during the school year (ranging from 1 to 2.35 per day). Teachers used materials from projects that were new to them (but not original TOMTOMS materials) introduced during the first TOMTOMS summer school on an average of 30.8 times during the year. They used original TOMTOMS material an average of 28.2 times during the year and their own original work an average of 44.7 times a year. The purposes given most frequently for choosing an activity were for warm-ups (79.1 times), practice (58.5 times), developing understanding (49.8 times), and developing problem solving skill (24.5 times). The instructional modes chosen were teacher instruction (46.2 times), large group discussion (56.8 times), small group work (25.7 times), individual seatwork (64.6 times), homework (37.7 times), lab discovery (10.2 times), pairs (27.7 times), cooperative learning (15.8 times), and project (7.4 times). The manipulatives/tools/technology used most frequently were calculators (34.6 times), computers (8.1 times), and measurement devices (6.4 times).

Questionnaire. Teacher questionnaire data were reported during each of the summer sessions, before and after the TOMTOMS school year. As indicated in Table 4, teachers report significant decreases in time spent preparing for classes, grading homework, and making and grading tests between the first and second

Table 3

Mean Number of Times Teachers (N=17) Included Each Category in Calendars for the TOMTOMS Seventh Grade Class

		Mean	Standard Deviation
1.	New materials used		
	New to participant, but from other sources	30.8	29.7
	TOMTOMS leadership packet	28.2	20.2
	TOMTOMS participant original work	44.7	73.6
2.	Purpose of the activity		
	Warm-up	79.1	126.5
	Check prerequisite skill	6.7	11.0
	Foreshadow a coming development	7.8	11.2
	Developing a positive attitude	12.2	15.4
	Motivation	16.2	21.3
	Developing understanding	49.8	35.1
	Practice	58.5	45.6
	Application	18.7	16.9
	Maintainance of skill	18.3	15.0
	Recreation	5.9	7.3
	Filler	3.1	3.5
	Developing problem solving skill	24.5	26.4
	Closure	6.2	10.4
	Assignments	9.5	12.5
	Total activities	242.7	103.1
3.	Instructional mode		
	Teacher instruction	46.2	39.6
	Large group discussion	56.8	54.4
	Small group work	25.7	19.0
	Individual seatwork	64.6	60.3
	Homework	37.7	30.4
	Lab discovery	10.2	22.3
	Pairs	27.7	28.1
	Coop learning	15.8	20.0
	Project	7.4	18.5

Table 3 (continued)

Mean Number of Times Teachers (N=17) Included Each Category in Calendars for the TOMTOMS Seventh Grade Class

	Mean	Standard Deviation
4. Manipulatives and tools		
Computers	8.1	8.5
Calculators	34.6	29.3
Compasses and/or protractors	7.1	6.7
Measurement devices	6.4	9.9
Algebra tiles	2.7	7.3
Base ten blocks	.5	.8
Miras	.2	.4
Pentominoes	.6	1.8
Tangrams	.6	1.5
Probability materials	3.5	8.4
Pattern blocks	2.2	3.8
Geometric figures	2.7	3.7
Other	19.5	20.8

Table 4

Teacher Questionnaire Descriptive Before and After the TOMTOMS Year

		Summer '90		Summer '91			
		Mean	SD	Mean	SD	t	p
1.	Hours per week spent on:						
	a. preparing for classes	7.9	5.5	3.6	2.6	3.60	.00**
	b. grading homework	4.4	2.5	2.1	1.1	4.10	.00**
	c. making and grading tests	2.8	1.8	1.8	1.3	2.50	.03*
	d. teaching	23.8	7.6	20.8	7.3	.30	.80
	e. other school	5.1	3.5	6.4	4.7	-1.30	.23
2.	Time available on weekly basis for preparing additional ideas for class besides basic course requirements-(none=1 to a lot=5 scale)	2.4	.7	3.8	.2	-4.60	.00**
3.	Need for materials in addition to the text (none=1 to a lot= 5 scale)	3.9	.9	4.3	1.0	-1.80	.08
4.	Flexibility in curriculum to include alternative activities (none=1 to a lot=5 scale)	4.4	.8	4.2	1.0	1.30	.21
5.	Encouragement for using course materials other than text (none=1 to a lot=5 scale)	3.9	1.2	3.8	1.4	.60	.59
6.	Percent of available time in a typical week.						
	a. development/maintenance of concept/skills.	42.8	15.3	36.8	13.2	2.10	.06
	b. applications of concepts/skills	25.0	15.0	26.7	12.8	-.49	.63
	c. problem solving	17.5	9.9	19.1	6.0	-8.70	.40
	d. open-ended investigations	4.7	5.4	13.3	7.0	-5.20	.00**
	e. other	4.7	6.9	5.9	6.9	-.42	.68

Table 4 (continued)

Teacher Questionnaire Descriptive Before and After the TOMTOMS Year

	Summer '90		Summer '91			
	Mean	SD	Mean	SD	t	p
7. Percentage of students in class competent following activities:						
a. development/maintenance of concept/skills.	68.3	20.8	73.0	21.9	-.97	.35
b. applications of concepts/skills	64.1	18.5	53.6	21.9	2.00	.06
c. problem solving	45.3	23.4	52.3	21.5	-1.13	.28
d. open-ended investigations	21.7	23.6	32.5	24.0	-1.65	.12
e. other	5.6	22.5	0.0	0.0	1.00	.33
8. Percent of available time in class students spend in:						
a. large group discussion	27.6	13.5	33.4	14.4	-1.20	.26
b. cooperative small groups	36.5	23.2	35.7	17.7	.20	.84
c. independent work	27.4	15.4	26.5	16.5	.21	.84
d. other	8.5	15.6	3.8	8.9	1.20	.25
9. Time per week provided in class for homework (min/week).	83.4	26.3	41.5	34.3	3.86	.00*
10. Approximate number of weeks each year spent teaching:						
a. probability	1.6	.9	1.7	1.3	-.31	.77
b. statistics	1.3	.9	1.8	1.0	-1.60	.13
c. geometry	4.0	1.8	3.5	1.7	1.30	.22
d. measurement	2.5	1.6	2.1	1.7	.80	.44
e. algebraic concepts	8.9	13.1	3.6	3.4	1.60	.13
f. problem solving	6.9	9.5	10.3	12.9	-.93	.37
g. number/computation	14.1	9.1	8.4	5.3	2.44	.03*
h. graphing,patterns, relationships	4.4	4.2	3.3	1.8	.93	.37
i. integrated units	.9	1.5	5.8	8.5	-2.30	.03*
j. other	1.1	1.9	5.2	8.2	-1.90	.07

* $p < .05$. ** $p < .01$.

summers. They also report more time available on a weekly basis for preparing additional ideas for class besides basic course requirements. Teachers reported planning for significantly more time during the TOMTOMS year on open-ended investigations with their classes than they did in the prior year (from an average of 4.7% of class time each week to 13.3% during the TOMTOMS year). Teachers also provided significantly less time in class on homework during the TOMTOMS year (83.4 minutes/week as compared with 41.5 minutes/week). TOMTOMS classes spent significantly fewer weeks on number/computation units (14.1 to 8.4 weeks) and significantly more weeks on integrated units (.9 to 5.8 weeks).

TOMTOMS teachers and the NCTM Standards. In an exit interview at the end of the second summer, TOMTOMS teachers were asked to react to the standards as a guide for teaching mathematics today. Every teacher interviewed felt both documents, Curriculum Standards and Teaching Standards, were useful for a variety of reasons. Teacher answers generally fell into four categories:

(1) Both standards documents provide a vision for middle school mathematics to guide teacher thinking and planning about both what to teach and how to teach it. Eleven of the teachers commented specifically about this vision, of both overriding goals and of specific guidelines. Examples of comments on the Curriculum Standards:

As goals:

> "Parting of the clouds and the light shines through. I was so frustrated with the traditional approach. I was ready to open up a holistic approach to mathematics that will change the way I teach for the rest of my life. Well- founded and has a necessary place on every teachers desk. They make sense. They've seemed like the answer to me. They

are not really different from the others I've seen, they just help it to 'blend in'. "

"Especially the first four: problem solving, reasoning, connections, communication. Those are the keys--need to be woven through everything you do in math . . .lots of topics. That became clear to me this summer. The other things--very hands-on. Kids really become involved in the learning. Need to be actively learning. Students will need reinforcement but will know for a long time."

As specific guidelines:

"I'm finding I think in terms of the standards for math. Like, it covers different things kids should know and be able to do. It makes sense to me. Still, I use the text as a guide and use the standards as they fit. I use the standards more as an internal guide, as overriding goals."

"I like them because they help get rid of the other 'stuff'. Gives you things to center on, much like Math Their Way in primary school. "

"I liked the evaluation section in Curriculum Standards, different ways to assess students."

Examples of comments on the Teaching Standards:

"The situations--vignettes are helpful to me. The way I see my classes. My thinking is changing (about the curriculum), and connecting to my teaching. I'm thinking more globally about my teaching."

"The examples are the most valuable. Questioning styles and activity."

"Standards help me keep in perspective all the ways students need to be learning. Not just the integration of topics, probability and statistics, geometry. But that it makes sense to learn it by discovering

them . . . by making conjectures. Learn by doing. For example, we need to get kids actively involved. It also tells us what we should be covering."

(2) The standards validate existing beliefs. Four teachers commented specifically on this aspect of the standards documents:

"Yes, it gives us a guide. Like the ones this year (Teaching Standards) and last year (Curriculum Standards) reinforced what I already thought. Helps put things in order. Validated a lot of what I believed in. "

"Those were the ideas I believed before. They give validation for me that what I was doing was right. "

"Validate what you've heard and what you are doing. They help support feelings that I have done the right thing and my development has progressed."

" Most of us in the program are relatively active in mathematics education. We are committed philosophically."

(3) Both standards serve as a guide for future professional growth.

" I get it out (the Curriculum Standards) to make sure of what you should cover. It gives me a better feeling of how I can do both arithmetic and other standards. It gives me a guide to work towards."

"Yes, the (Curriculum) Standards make sense to me. They involve all levels of thinking (for teachers and students) and integration is the focus. I use them mostly to cross-reference with TOMTOMS. Good things and ideas for me. One I plan on investigating is examining how math can be connected to nature. I also plan to expand this to other areas."

"Helps make sense of what I'm doing. I used them (Curriculum Standards) several times last year to look things up. Also in the Teaching Standards. Helps me get to the particulars."

"It's good to have a reminder. Good teachers will be striving to do these already. To help us grow and practice. Also good for buying textbooks."

"They are broad. But they make sense. But knowing how to implement . . . These are things everyone would like to see. But the nitty-gritty of getting things to happen is the hard part. Individual application will be different."

"The parts I'm weak in and parts to improve. The standards are idealistic, they are to strive towards. Keep me going ahead. Gives me a guideline and tells me what is appropriate and what to work on."

"For a teacher to do a really good job, they need a deep personal understanding of math. This is not talked about very much. Teachers have the most difficulty with teaching the meaning behind the math."

"The Teaching Standards. These demonstrate actual teacher talk which is different from our own past experiences. That helped me to understand better. I'm working on teacher talk."

(4) Both standards documents serve as position papers about middle school mathematics teaching for "other" mathematics teachers, for supervisors and evaluators, and for parents. Six TOMTOMS teachers talked about this. On teachers:

"The only problem I have - - why aren't all teachers given a copy? Other teachers in my building don't know about implementing the standards."

"They (Curriculum Standards and Teaching Standards) will help me to show others (teachers)."

On supervisors and evaluators:

" All principals need a copy of both books!"

"I use them for justifying what I want to do."

"The second set (Teaching Standards) requires the support of evaluators and supervisors. I feel like I'm alone in the middle of the pool. Someone needs to be saying I'm doing ok. I'm sorry that administrators and evaluators don't get it. But the Standards help."

"They (Curriculum Standards and Teaching Standards) will help us politically .--with both administration and other teachers. We can use it that way as a tool--a conversion tool. "

And finally, on parents:

"They (Curriculum Standards and Teaching Standards) are a start. It is the same as we've talked about in the past. Hasn't gone far enough in mandating change, especially people who don't take responsibility. For example: problem solving and alternative assessment. The buy-in is marginal with administration and parents."

Correlations of TOMTOMS' Teacher Calendars and Questionnaires with Student Achievement Gain

Teacher calendars and student achievement gain. Table 5 shows the correlations of TOMTOMS teacher calendar data with student achievement residual gains. Significant correlations indicate that:

1. Students in classes with **higher** gains (between pretest and posttest) in the second and third sections of the achievement test had teachers who more often chose activities to foreshadow a coming development .

Table 5

Correlations of TOMTOMS Teacher Calendars With Student Residual Gain in Achievement.

		Residual Gain in Achievement			
		Section 1	Section 2	Section 3	Total
1.	Materials				
	New, but from other sources	.38	.45	.31	.41
	TOMTOMS Leadership	.05	.37	.23	.10
	TOMTOMS Participant	.44	.41	.41	.40
2.	Purpose of the activity				
	Warm-up	.47	.21	.15	.36
	Check prerequisite skill	-.13	.03	.01	-.19
	Foreshadow a coming development	.27	.53*	.49*	.46
	Developing a positive attitude	-.02	.48	.25	.27
	Motivation	.06	.12	.18	.23
	Developing understanding	-.13	-.01	-.14	-.11
	Practice	-.06	.23	.01	.10
	Application	-.15	.22	.27	.17
	Maintainance of skill	.15	.61*	.23	.27
	Recreation	.06	.48	.30	.31
	Filler	-.31	-.03	-.33	-.23
	Developing problem solving skill	.21	.48	.23	.38
	Closure	-.08	.27	-.01	.09
	Assignments	-.07	.02	-.35	-.28
	Total activities	.30	.76**	.62**	.56*
3.	Instructional mode				
	Teacher instruction	-.26	.07	.06	-.12
	Large group discussion	.39	.47	.15	.35
	Small group work	-.02	.50*	.32	.21
	Individual seatwork	-.19	.21	-.11	-.04
	Homework	-.14	.29	.07	.03
	Lab or discovery	.30	-.08	-.12	.14
	Pairs	.38	.68**	.57*	.63**
	Coop learning	.26	.45	.41	.42
	Project	.34	-.03	-.08	.20

Table 5 (continued)

Correlations of TOMTOMS Teacher Calendars With Student Residual Gain in Achievement.

		Residual Gain in Achievement			
		Section 1	Section 2	Section 3	Total
4.	Manipulatives and tools	.08	.52*	.52*	.43
	Computers	-.17	-.16	-.13	-.22
	Calculators	.03	.29	.17	.04
	Compasses and/or protractors	.28	.12	-.20	.03
	Measurement devices	.41	.60*	.56*	.60*
	Algebra tiles	.36	.52*	.55*	.63*
	Base ten blocks	.20	.47	.49	.51
	Miras	-.46	-.40	-.31	-.43
	Pentominoes	-.32	-.02	-.33	-.25
	Tangrams	-.13	.11	.22	.09
	Probability materials	.35	.54*	.59*	.64*
	Pattern blocks	-.53*	-.33	-.18	-.38
	Geometric figures	.22	.23	.26	.23
	Other	-.13	.37	.44	.31

* $p < .05$. ** $p < .01$.

2. Students in classes with **higher** gains on the second section of the achievement test had teachers who chose more activities that would maintain a skill.

3. Students in classes with **higher** gains in the second and third sections of the test and on the total test had teachers who used more activities in their instruction.

4. Students in classes with **higher** achievement gains had teachers who used more pairs and small group work.

5. Students in classes with **higher** achievement gains had teachers who used manipulatives and tools (particularly measurement devices, algebra tiles, and probability materials.

Teacher questionnaires and student achievement residual gain. Table 6 displays correlations of teacher questionnaire data with student achievement residual gains. Significant correlations indicate that:

1. Teachers who provide a greater percent of time in a typical week on problem solving work have students with **higher** gains on Section One of the test.

2. Teachers who spend more weeks teaching geometry have students with **higher** gains on Sections Two and Three, and total achievement.

3. Teachers who spend more weeks teaching algebraic concepts have students with **higher** gains on Section One of the achievement test.

3. Teachers who spend more weeks teaching number/computation concepts have students with **lower** gains on Section Three of the achievement test.

Correlations of TOMTOMS Teacher Calendar Data with Student Attitudes/Beliefs

Table 7, 8, 9 and 10 display the correlations between TOMTOMS teacher calendar means and student attitude/belief residual gains scores (derived from pretest-posttest data). Student attitudes/beliefs that are significantly correlated with more than six teacher calendar categories include the following:

Table 6

Correlation of Teacher Questionnaire With Student Achievement Residual Gain

		Student Achievement Residual Gain			
		Section 1	Section 2	Section 3	Total Test
1.	Hours per week spent on:				
	a. preparing for classes	.14	-.13	.01	.04
	b. grading homework	.04	-.23	.13	.03
	c. making and grading tests	.00	-.03	.10	.01
	d. teaching	-.03	.03	-.13	-.08
	e. other school	.06	.05	-.18	-.05
2.	Time available on weekly basis for preparing additional ideas for class besides basic course requirements-(none=1 to a lot=5 scale)	.40	.15	.38	.35
3.	Need for materials in addition to the text (none=1 to a lot=5 scale)	-.18	.01	.37	.22
4.	Flexibility in curriculum to include alternative activities (none=1 to a lot=5 scale)	-.27	-.13	.07	-.01
5.	Encouragement for using course materials other than text (none=1 to a lot=5 scale)	-.06	.22	.39	.32
6.	Percent of available time in a typical week.				
	a. development/maintenance of concept/skills.	-.21	-.12	-.26	-.18
	b. applications of concepts/skills	.23	.12	.11	.23
	c. problem solving	.61*	.34	.28	.38
	d. open-ended investigations	.19	-.06	.10	-.01
	e. other	-.61*	-.31	-.17	-.42

Table 6 (continued)

Correlation of Teacher Questionnaire With Student Achievement Residual Gain

	Student Achievement Residual Gain			
	Section 1	Section 2	Section 3	Total Test
7. Percentage of students in class competent at following activities:				
a. development/maintenance of concept/skills.	-.29	-.30	-.15	-.39
b. applications of concepts/skills	.20	.09	.06	.07
c. problem solving	-.27	-.28	-.06	-.32
d. open-ended investigations	.29	.20	.18	.18
8. Percent of available time in class students spend in:				
a. large group discussion	-.38	.02	.25	-.11
b. cooperative small groups	.07	-.22	-.24	-.11
c. independent work	.01	-.09	-.19	-.08
d. other	.35	.52*	.48	.54*
9. Time per week provided in class for homework.	.38	-.01	-.26	.03
10. Approximate number of weeks each year spent teaching:				
a. probability	-.03	.08	.35	.15
b. statistics	.20	.34	.35	.46
c. geometry	.43	.56*	.65**	.68**
d. measurement	.13	.04	.05	.07
e. algebraic concepts	.51*	.41	.28	.39
f. problem solving	-.15	-.09	-.05	-.11
g. number/computation	-.44	-.28	-.54*	-.47
h. graphing,patterns, relationships	.22	-.04	-.14	.04
i. integrated units	-.36	-.06	-.33	-.33
j. other	-.64**	-.30	-.02	-.37

* $p < .05$. ** $p < .01$.

Table 7

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 1-4)

		Residual Grains for Items			
		1	2	3	4
1.	Materials				
	New, but from other sources	-.30	.25	.19	.13
	TOMTOMS Leadership	-.33	-.10	-.15	.22
	TOMTOMS Participant	-.20	.34	.48*	.27
2.	Purpose of the activity				
	Warm-up	.11	-.16	-.44	.07
	Check prerequisite skill	-.26	-.37	-.09	-.13
	Foreshadow a coming development	-.31	.23	.55*	.20
	Developing a positive attitude	-.23	.14	.47	.53*
	Motivation	.10	.34	-.06	.32
	Developing understanding	-.14	-.13	-.30	.46
	Practice	-.13	.14	.08	.52*
	Application	-.23	-.07	.11	.47
	Maintainance of skill	.15	-.05	.46	.49*
	Recreation	-.30	.15	.46	.68**
	Filler	-.20	.07	.32	.46
	Developing problem solving skill	-.24	.11	.40	.65**
	Closure	-.05	-.24	.32	.58*
	Assignments	-.13	-.56*	-.06	.35
	Total activities	-.09	.09	.23	.23
3.	Instructional mode				
	Teacher instruction	-.10	-.40	-.43	.34
	Large group discussion	-.26	-.10	.16	.39
	Small group work	-.31	-.11	.03	.36
	Individual seatwork	-.06	-.02	.13	.48*
	Homework	-.24	-.06	.13	.35
	Lab or discovery	.16	-.24	-.52*	.16
	Pairs	-.31	.40	.33	.29
	Coop learning	-.25	.00	.26	.06
	Project	.13	-.05	-.49*	.07

Table 7 (continued)

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 1-4)

		Residual Grains for Items			
		1	2	3	4
4.	Manipulatives and tools	-.26	-.28	.16	.66**
	Computers	-.47	.06	.02	.03
	Calculators	-.36	.07	.12	-.10
	Compasses and/or protractors	-.16	.14	.40	.20
	Measurement devices	.05	.38	.35	.27
	Algebra tiles	-.09	.55*	.58*	-.01
	Base ten blocks	-.22	.32	.05	-.33
	Miras	.15	-.43	.07	.33
	Pentominoes	.12	-.02	-.21	-.22
	Tangrams	-.15	.49	.59*	.22
	Probability materials	-.28	.47	.16	-.30
	Pattern blocks	-.01	-.10	-.28	.24
	Geometric figures	-.28	.22	.32	.39
	Other	-.13	.37	.44	.31

* $p < .05$. ** $p < .01$.

Table 8

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 5-8)

		Residual Grains for Items			
		5	6	7	8
1.	Materials				
	New, but from other sources	-.44	-.02	.52*	-.03
	TOMTOMS Leadership	-.28	-.07	.32	-.31
	TOMTOMS Participant	-.04	.15	.65**	-.12
2.	Purpose of the activity				
	Warm-up	.22	.25	-.20	.06
	Check prerequisite skill	-.22	.07	.38	-.59*
	Foreshadow a coming development	-.27	.10	.70**	-.34
	Developing a positive attitude	-.06	.12	.51*	-.40
	Motivation	.06	-.31	.14	.36
	Developing understanding	.13	-.01	.10	-.02
	Practice	.09	-.09	.27	.01
	Application	-.31	-.04	.18	-.28
	Maintainance of skill	.39	.09	.49*	-.49*
	Recreation	-.38	-.12	.31	-.23
	Filler	.20	.15	-.20	-.04
	Developing problem solving skill	-.33	-.04	.33	-.20
	Closure	.02	.18	.02	-.47
	Assignments	-.04	.14	.10	-.31
	Total activities	.01	.37	.41	-.18
3.	Instructional mode				
	Teacher instruction	.09	-.03	-.05	-.27
	Large group discussion	-.04	.27	.50*	-.17
	Small group work	-.25	.04	.35	-.45
	Individual seatwork	.16	-.07	.17	-.12
	Homework	.11	.26	-.18	-.03
	Lab or discovery	.18	.10	-.40	.10
	Pairs	-.29	-.07	.71**	-.17
	Coop learning	-.25	.07	.53*	-.23
	Project	.26	.14	-.32	.21

Table 8 (continued)

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 5-8)

	Residual Grains for Items			
	5	6	7	8
4. Manipulatives and tools				
Computers	-.26	.04	-.05	.15
Calculators	-.27	-.05	.75**	-.31
Compasses and/or protractors	.00	.41	.55*	-.02
Measurement devices	-.40	.04	.70**	.37
Algebra tiles	-.05	-.05	.51*	.03
Base ten blocks	.07	.09	.50	-.02
Miras	.16	-.09	.05	.18
Pentominoes	.16	.01	-.10	-.41
Tangrams	.03	-.12	-.02	-.05
Probability materials	-.15	.04	.60**	-.08
Pattern blocks	.28	-.06	.19	.19
Geometric figures	-.28	-.24	.34	-.09
Other	-.17	.17	.48*	-.30

* $p < .05$. ** $p < .01$.

Table 9

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 9-14)

		Residual Grains for Items					
		9	10	11	12	13	14
1.	Materials						
	New, but from other sources	.20	-.07	-.05	.11	.01	-.26
	TOMTOMS Leadership	-.14	-.10	.20	-.24	-.14	.33
	TOMTOMS Participant	.07	.16	-.10	.19	-.05	-.30
2.	Purpose of the activity						
	Warm-up	-.05	-.59*	.21	-.37	-.12	.35
	Check prerequisite skill	-.40	-.23	-.07	-.11	-.47	.05
	Foreshadow a coming development	-.04	.20	-.18	.19	-.23	-.24
	Developing a positive attitude	-.12	.27	-.40	.02	-.13	.12
	Motivation	.34	-.14	.18	.10	.46	-.27
	Developing understanding	-.03	-.33	.08	-.27	.23	.16
	Practice	.14	-.08	-.09	.15	.32	.06
	Application	-.18	.37	-.10	.22	.27	-.23
	Maintainance of skill	-.14	.27	-.34	-.22	-.27	.34
	Recreation	-.04	.46	-.24	-.01	-.14	.20
	Filler	.00	.12	-.16	-.13	.23	-.03
	Developing problem solving skill	-.01	.24	-.32	-.15	-.11	-.18
	Closure	-.35	.17	-.14	-.06	.04	.13
	Assignments	-.34	-.17	-.06	-.58*	.01	.48
	Total activities	-.25	.11	.09	-.17	-.17	.11
3.	Instructional mode						
	Teacher instruction	-.44	-.30	.22	-.26	-.01	.18
	Large group discussion	.03	-.12	-.18	-.34	.01	.36
	Small group work	-.23	.17	-.33	-.19	-.15	.29
	Individual seatwork	-.01	-.06	-.09	-.22	.30	.17
	Homework	-.33	.16	-.33	-.59*	-.21	.23
	Lab or discovery	-.04	-.64**	.25	-.34	-.03	.28
	Pairs	.23	.09	-.25	.09	-.16	.05
	Coop learning	.03	.23	.08	.14	.10	.06
	Project	-.02	-.04	.09	-.03	-.24	.15

Table 9 (continued)

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 9-14)

		Residual Grains for Items					
		9	10	11	12	13	14
4.	Manipulatives and tools	.07	.26	-.11	.29	-.08	-.29
	Computers	-.32	.35	.09	-.36	.16	-.03
	Calculators	.04	-.16	-.24	-.18	-.38	.23
	Compasses and/or protractors	.26	-.33	-.55*	-.37	-.14	.29
	Measurement devices	-.01	.14	-.18	.22	-.20	-.15
	Algebra tiles	.21	.11	.05	.30	.22	-.28
	Base ten blocks	.33	.31	.02	.59*	.02	-.21
	Miras	.18	-.18	-.31	.02	-.08	-.48
	Pentominoes	-.38	.45	-.07	.32	-.04	-.23
	Tangrams	.10	.13	.34	.41	.16	.20
	Probability materials	.18	.29	-.18	.34	-.05	-.33
	Pattern blocks	.21	-.07	-.19	.16	-.08	-.48
	Geometric figures	.00	-.29	.16	-.09	.00	.07
	Other	-.13	.45	-.07	.32	-.03	-.23

* $p < .05$. ** $p < .01$.

Table 10

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 15-22)

	Residual Grains for Items							
	15	16	17	18	19	20	21	22
1. Materials								
New, but from other sources	.34	.10	.12	.62**	.44	-.15	.32	.18
TOMTOMS Leadership	-.16	.48*	.35	.09	.04	.14	-.16	-.46
TOMTOMS Participant	.50*	.15	-.11	.33	.31	-.17	-.01	.06
2. Purpose of the activity								
Warm-up	.23	.26	.10	-.32	-.01	-.49	.29	.17
Check prerequisite skill	-.14	.17	-.46	.02	.13	-.25	-.43	-.19
Foreshadow a coming development	.42	.10	.04	.27	.52*	.06	-.09	-.03
Developing a positive attitude	.06	.20	-.37	.15	.06	-.16	-.32	-.26
Motivation	.46	.23	.05	.29	-.04	-.34	.29	.10
Developing understanding	.16	.59*	.02	.11	.01	-.32	-.18	-.47
Practice	.21	.39	-.21	.36	-.01	-.34	.00	-.20
Application	-.19	-.21	-.16	.06	-.32	-.36	-.20	-.17
Maintainance of skill	-.18	.26	-.23	.28	.32	.14	-.26	-.31
Recreation	-.22	.24	-.39	.01	.08	.03	-.24	-.16
Filler	-.11	.10	-.69**	.34	.26	-.30	-.21	-.18
Developing problem solving skill	-.08	.23	-.46	.11	.16	-.21	-.08	.01
Closure	-.15	.16	-.46	.02	.13	-.25	-.44	-.19
Assignments	-.19	-.21	-.16	.06	-.33	-.36	-.20	-.17
Total activities	.19	.20	.27	.18	.00	.11	-.02	-.02
3. Instructional mode								
Teacher instruction	-.09	.41	.22	-.14	-.19	-.24	-.46	-.63**
Large group discussion	.27	.56*	.07	.29	.24	-.03	.07	-.07
Small group work	-.24	.08	.01	.17	-.26	-.08	-.23	-.43
Individual seatwork	.01	.34	-.31	.39	-.04	-.26	-.12	-.24
Homework	-.47	-.15	-.54	.19	-.17	-.37	-.05	-.04
Lab or discovery	.12	.33	-.08	-.41	.04	-.60*	.17	.11
Pairs	.39	.15	.02	.23	.14	-.16	.16	-.06
Coop learning	.08	-.05	.19	.13	-.10	-.01	.19	.12
Project	.14	.08	.14	-.47	-.17	.38	-.19	-.07

Table 10 (continued)

Correlations of TOMTOMS Teacher Calendar Items with Student Attitude and Belief Residual Gains (Items 15-22)

		Residual Grains for Items							
		15	16	17	18	19	20	21	22
4.	Manipulatives and tools	.38	.03	.03	.28	.13	-.09	-.10	-.11
	Computers	-.44	.42	-.18	.06	.13	.12	-.24	-.03
	Calculators	.20	.47	.31	.23	.26	.20	-.19	-.56*
	Compasses and/or protractors	.33	.25	-.02	.42	.30	.08	.18	-.06
	Measurement devices	.42	.04	.16	.14	.31	-.02	-.04	.03
	Algebra tiles	.64**	.12	.15	.28	.12	-.22	.26	.21
	Base ten blocks	.60*	-.20	-.04	.00	.13	.10	.10	.10
	Miras	.10	-.44	-.41	.34	.14	-.41	.07	-.03
	Pentominoes	-.33	.14	-.42	.12	-.08	-.46	-.40	-.17
	Tangrams	-.14	-.31	.23	-.41	-.66	.11	-.01	-.13
	Probability materials	.61*	.01	-.01	.23	.28	-.16	.17	.21
	Pattern blocks	.23	-.28	-.33	.28	.14	-.25	.01	-.13
	Geometric figures	.31	.52*	.51*	.04	.12	-.03	-.07	-.30
	Other	.08	-.06	-.17	-.01	-.15	-.36	-.29	-.20

* $p < .05$. ** $p < .01$.

1. During the school year, students who **increased** their ratings the most of the statement , Math that I learn in school describes the world in some way, were in classes where their teachers chose more activities :

- that they had written themselves,
- served the purpose of foreshadowing a coming development, and
- used algebra tiles and tangrams,

but **decreased** their ratings where their teachers chose more activities:

- for lab or discovery, or
- projects.

2. During the school year, students who **increased** their ratings the most of the statement, Math is related to other subjects in school, were in classes where their teachers chose more activities for the reasons:

- to develop problem solving skill,
- that use manipulatives and tools,
- to practice,
- to maintain a skill,
- for closure,
- for individual seatwork,
- to develop a positive attitude,
- for recreation.

3. During the school year, students who **increased** their ratings the most of the statement , Good math teachers show students lots of ways to look at the same problem, were in classes where their teachers:

- chose more activities from new sources introduced during the first summer of the project and from their own original work,

• listed the following purposes more often for choosing an activity: foreshadow a coming development, develop a positive attitude, and maintain a skill,

• chose a combination of large group discussion, student pairs, and small group work as their instructional mode,

• used manipulatives and tools (particularly calculators, compasses, protractors, measurement tools, algebra tiles, probability materials, and others).

Discussion

Achievement Gain

The most achievement gain by both TOMTOMS and control groups was on the computational portion of the test, reflecting the traditional emphasis at this level. Small gains, however, were realized both in the area of word problems and problem solving.

The lack of achievement residual gain differences between TOMTOMS and control groups indicates that more emphasis on problem solving and making connections (to other school subjects and the world around us) than on computation skill does not result in lower achievement on typical seventh-grade work. Explanations for this lack of difference may be due to the short length of time measured by the project. Also, the TOMTOMS year was spent trying new materials using teaching methods, tools, and assessment practices that were often times new to the participants. It usually takes more than one year to "work out the kinks." The project also did not measure teacher skill in integrating these new methods into their classrooms since evaluative observations were not made. Nor were any comparisons of effective teaching skills made between TOMTOMS and control groups. Another explanation for this lack of difference between groups may be that since control teachers were often in the same building and department as

TOMTOMS participants, sharing of successful activities between classrooms was bound to take place.

Student Attitudes /Beliefs

The TOMTOMS effort emphasized connections of mathematics to other school subjects and applications to the real world. The most interesting result in this area is that TOMTOMS students felt more strongly at the end of the year that math describes the world in some way. The gain still left the average on a negative side of neutral, but if continued efforts were made throughout the school experience, more positive attitudes might occur in this area.

The emphasis in the program on problem solving is reflected in the student drop in ratings of opinions on right and wrong answers in mathematics. This result may reflect a change from product to more process-oriented classrooms, where problem solving strategies and thinking skills are encouraged. Or, an increased emphasis on estimation and mathematical modeling and statistics, where student research design for the purpose of describing and prediction is taught, may reflect this real world use of mathematics where "alternative" or "better" answers are rewarded instead of specific correct answers.

Teacher Calendars and Questionnaires

TOMTOMS teachers used an average of 59 (30.8 new from other sources plus 28.2 TOMTOMS) new activities during the TOMTOMS year. In addition, they developed their own activities an average of 45 times during the year. This fact alone reflects the commitment of the TOMTOMS group to changing and improving their own practice and willingness to go through the stages of developing new curriculum materials that other middle school teachers might use. Whether any of this commitment can be claimed by the TOMTOMS staff development effort is uncertain, since the teachers volunteered for the program and already had a strong commitment to improving middle school mathematics teaching. However, the

teachers overwhelmingly (100%) indicated in the exit interview that the opportunity to work and plan with other "expert" middle school teachers with similar teaching philosophies was the major benefit of participating in this program.

The purposes for choosing activities are different from traditional mathematics teaching practice which emphasizes algorithmic skill and instrumental understanding. In contrast, TOMTOMS teachers often chose activities that would develop understanding and problem solving skill with the hope for developing relational understanding (Skemp, 1987). TOMTOMS teachers also used a variety of teaching methods: mixing teacher instruction, discussion, and small group work. Manipulatives, tools, and technology were often used to reach mathematics goals and objectives.

A benefit for participating in this staff development program appears to be freeing up planning time for teachers. Since teachers are usually so busy during the year, the opportunity to make an advanced yearly plan for their seventh-grade classes made more time available during the year for preparing additional ideas. The end result was that teachers spent more time in their classes on integrated units and open-ended investigations than on number/computation units with intentions to "do more next year."

Correlations

Teachers who used a more constructivist approach (using activities that foreshadow a coming development, problem solving, using more manipulatives and tools), mixed with effective teaching methods (variety of activities, pairs and small group work, distributed practice--maintaining skill); and larger doses of algebra and geometry concepts had larger achievement residual gains. Many of these gains were reflected in the more difficult portions of the achievement test. In addition, it is not surprising that teachers who spent more time developing computation skill did worse on the problem solving portion of the test.

These results may indicate the success of the TOMTOMS staff development effort. Or we must consider the possibility that teachers are more willing to try a more activity-oriented approach in classes where the students are better mathematics students already.

In addition, during the TOMTOMS year, some teachers were able to increase the strength of student attitudes/ beliefs about math describing the world in some way, that math is related to other subjects in school, and that good math teachers show students lots of ways to look at the same problem. These teachers were able to do this by choosing more activities which espouse the TOMTOMS and the Curriculum Standards and Teaching Standards philosophy: using manipulatives and tools appeared in all three lists, foreshadowing a coming development appeared in two, developing a positive attitude appeared in two, and used effective teaching practices (maintaining skill and using a variety of teaching techniques and materials) appeared in two.

The decreased ratings by students on the attitude: math that I learn in school describes the world in some way by teachers who used more lab/discovery lessons and projects is puzzling. Explanations for this phenomena may include level of teacher management skill. Two of the most creative teachers, who used the most labs and projects in their teaching, were second year teachers. They may not have been able to involve their students as well as more experienced teachers (Leinhardt, 1989). In the final interview one of these teachers commented on the fact that "my students kept me from reaching my goals." Informal observations in this class also indicated management problems.

Conclusions

According to the TOMTOMS teachers, this focused effort to improve middle school mathematics teaching by using a curriculum development model was successful. As one teacher stated,

"The experience has changed me. . . made me aware of what I'm doing and what I'm not doing. Once a person has changed, you can't go back. I have a motivation to become a better teacher."

A second teacher replied,

"My whole way of thinking has changed. I used to be a very traditional teacher. But I've been inspired by others to become a risk taker."

Another teacher said,

The data support these claims: Teachers used new materials, methods, and tools in their TOMTOMS classes. TOMTOMS teachers were willing to change their teaching from the traditional starting with specific objectives (eg. learning to multiply fractions) to general applications (If 2/3's of the bag of 78 M & M's is either brown or tan, find the number of brown or tan M & M's) to using activities that foreshadow coming developments (such as the M & M problem) before teaching specific procedures. One teacher said, "Students were often given tasks they had no specific background to relate to. They would decide on a direction and follow it as far as possible, then check to see if it was reasonable--sometimes refining their strategies and other times redoing their approach."

These teachers were able to increase achievement and attitudes by planning a variety of activities, by using activities to develop understanding and problem solving skill, and using effective teaching techniques. This result bolsters other research efforts (Romberg & Carpenter, 1986).

In addition to these results, teachers also pilot tested new materials, wrote new student activities related to the towns in which students lived, and prepared these materials for distribution. They also made staff development plans for their own school districts and hosted a state-level conference for middle school teachers, showcasing their curriculum project. These efforts alone are laudable.

It is left to future research, of course, to determine whether these correlational results can be reflected in an experimental study with teachers from the general population who may not be as philosophically aligned with the Curriculum Standards and the Teaching Standards. The TOMTOMS group was chosen because of this alignment. We also cannot predict the lasting effect of this effort on the TOMTOMS group and their subsequent staff development efforts until follow-up studies are completed. But we can say,hesitatingly at least, that the effort to improve the teaching of middle school mathematics as recommended by the calls for reform in the Curriculum Standards and Teaching Standards appears to obtain the desired results, changing teacher behaviors.

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APPENDICES

APPENDIX A

SYMPOSIUM AGENDA

MIDDLE SCHOOL MATHEMATICS: CURRICULUM FOR THE 90'S AND BEYOND
A TOM TOMS* symposium
January 15, 1990
Department of Science, Mathematics, and Computer Science
Oregon State University

I.	8:30	--	Memorial Union 109, Coffee and Rolls -- Introductions
II.	9:00	--	Problem Solving Kick-off -- Maggie Niess
III.	10:00	--	NCTM Standards and Middle School Math -- Sue McGraw
IV.	11:00	--	Small Groups--Standards/Comprehensive curriculum goals/ Middle School Math
V.	11:50	--	Reimbursement forms
VI.	12:00	--	MU 109A, Lunch served
VII.	12:50	--	Short Leader/writer meeting Weniger 247
VIII.	1:00	--	Curriculum Building, Weniger 247 -- Linda Foreman
IX.	2:00	--	Small group brainstorming on topics
X.	3:45	--	Wrap it up.
XI.	4:00	--	Leader/writer meeting-- for meetings
dates			

TOM TOMS:The Oregon Mathematics Teachers of Middle School Project

Participant/Small Group List

A TOM TOMS symposium
Middle School Mathematics:
Curriculum for the 90's and Beyond

A. Fractions and Decimals
Leader/writer: Joan Miller
Consultants: Joel Narva
Michael Day
Alice Mullally
Dave Moore

B. Ratio, Proportions, Percent
Leader/writer: Cathy Brown
Consultants: Fred Rectanus
Judy Johnson
Tami Matsumoto
Linda Crafton

C. Geometry -- Angles and shapes
Leader/writer: Kris Warloe
Consultants: Karen Higgens
Don Fineran
Madeline Moore
Maggie Niess

D. Concept of variable and solving equations
Leader/writer: Joanne Wilke
Consultants: Scott McFadden
Tony Jongjon
Linda Foreman

E. Graphs
Leader/writer: Jim Specht
Consultants: Jerry Johnson
Sue McGraw
Dianne Erickson

TEN WORKSHOPS FOR MIDDLE SCHOOL TEACHERS IN LINN BENTON COUNTY

funded by Eisehower Title II

1: When -- 4-7:00 on Wednesdays, dates as listed below

2: Purpose -- to share materials and methods in the spirit of Oregon Math Curriculum Goals and NCTM Standards with Middle School Teachers

3: Where -- Weniger 247, OSU

4: Format -- Approximately 1 hour of large group
1 hour of lab
1 hour planning, journalizing, discussing

5: Food -- A snack will be provided

Sign up if you would be interested in organizing a workshop (staff support in running off materials and organizing labs will be provided)

1.	February 21	Math Micro Worlds	Maggie Niess
2.	March 7	Ratio, Prop, Percent	_____
3.	March 28	Geometry of <'s, shapes	_____
4.	April 11	Variables and Equations	_____
5.	April 25	Graphs, formulas, patterns	_____
6.	May 9	Spatial Visualization	_____
7.	May 23	Probability and Stats	_____
8.	Aug 29 tentative	Problem Solving	_____
9.	September 12	Fractions & Decimals I	_____
10.	September 26	Fractions & Decimals II M & M's	_____

APPENDIX B

STUDENT ACHIEVEMENT TEST

TOMTOMS Project

_____ 1. Name_____

_____ 2. Teacher_____ 3. Period_____

4. Grade _____

5. School_____

6. School's City_____

7. Circle: Female Male

8. Birthdate _____

Try your best on this test, we want to find out what 7th graders know about math when they come to school in the fall. Some problems you may not be able to answer, but make a reasonable estimate if you can. This test will also ask you the kinds of math problems you like to work on and how interested you are in the problems you try.

1 2 3

Try your best on these problems. Some problems you may not be able to answer, but make a reasonable estimate if you can. If you want you may skip over a problem and come back to it after you have done the other problems. Feel free to make comments about ideas you have on solving problems even if you can't get an exact answer.

---

1. What number times 35 is 140? 1._____

2. $10^1 =$ 2._____

3. Find $-14 + 9$ 3._____

4. Find 30% of 50 4._____

5. Find $.2\overline{).014}$ 5._____

6. If $x = 3$ and $y = 1$ find $2x - y$ 6._____

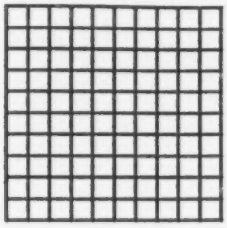
7. Find $3 + 2(12 - 7)$ 7._____

8. About how many centimeters long is this line? 8._____

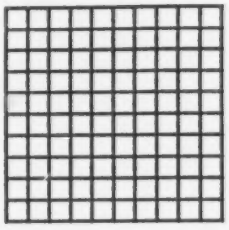
---

9. Grandma left Corvallis at 10:45 am. Her trip to Ashland took 4 hours and 20 minutes. What time did she get to Ashland? 9._____

10. a. Shade in 65% of the square:



b. Shade in $\frac{3}{5}$ of the square:



c. Which shaded part is bigger? 10c._____

11. Jane makes 2 out of every 3 baskets she shoots at the free throw line. If Jane shoots 42 times, how many baskets would she expect to make? 11._____
Show your work.

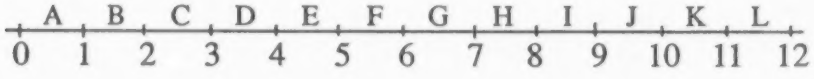
12. Suppose you have a strip of wood 10 inches long. You need to cut the strip into $\frac{3}{4}$ inch pieces.

a. How many $\frac{3}{4}$ inch pieces will you get? 12a._____

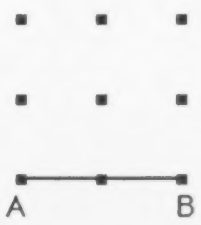
b. Is there any wood leftover? 12b._____
Explain how you got your answer.

13. Which letter corresponds to the section of the graph where you would expect to find the difference between $7\frac{1}{2}$ and $3\frac{2}{3}$?

13._____



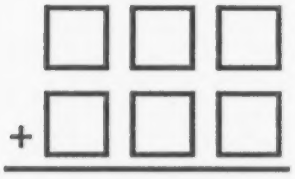
14. Draw as many isosceles triangles as you can with AB as one side and a point of the grid as the third vertex.



How many isosceles triangles did you draw? 14._____

15. Jay knows that half the students from his school play the piano. Also, half of the students play soccer. Jay thinks this adds up to 100% of the students. Jay may be wrong. Explain why you think Jay is right or wrong. If possible, draw a picture to explain your thinking.

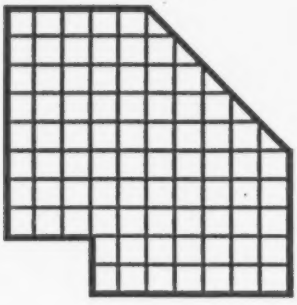
16. Using each of the numbers 1, 2, 3, 4, 5, 6 once, fill in the boxes at the right to get the largest possible answer. Show below as many other ways as you can find to get your answer.



17. The following picture shows you my garden. Each square is one square yard

a. How much fence will I have to buy to protect it? 17a._____

b. How many scoops of flower seed will I have to buy (1 scoop covers one square yard)? 17b._____



18. Cascade Breakfast Cereal Company wants to find out the favorite breakfast cereal of Middle School aged students in Medford and are willing to pay someone $5 per hour to find an approximate answer. Cascade will hire the person who will most likely find the right answer, but for the least amount of money. Make a plan for finding out the answer.

19. Toothpicks:

a. Make a square with 4 toothpicks.

b. Next make another square using one side of the first square.

How many toothpicks do you have now?

c. Make a third square in the same line. How many toothpicks do you have now?

d. Complete the chart at the right, adding squares in the same line.

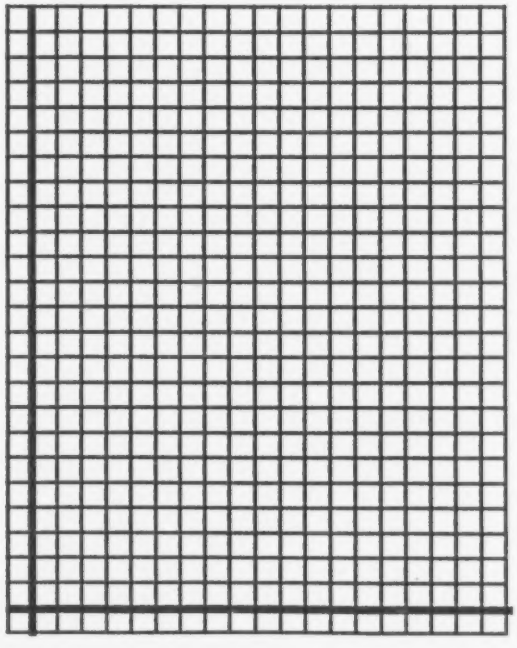
Squares	Toothpicks
0	0
1	4
2	
3	
4	
5	
6	

e. If you made 10 squares in a line, how many toothpicks would you need? 18e. _____

g. If you made 100 squares in a line, how many toothpicks would you need? 18f. _____

h. Can you state a rule for finding the number of toothpicks?

g. Make and label a graph of the data in your table:



_____

20. Choose the three problems you liked working on the best.
    List the numbers of these problems: _____ _____ _____

21. Choose the three problems you liked working on the least.
    List the numbers of these problems: _____ _____ _____

22. Are there some problems on which you wish you could have spent more time?_____
    If so, list the numbers of these problems:

23. Did you use a calculator on this test ?_____
    If so, list the numbers of the problems on which you used it.

24. What is your opinion of this test?

APPENDIX C

STUDENT QUESTIONNAIRE

Student Questionnaire, TOMTOMS PROJECT

We are interested in your ideas about mathematics. Your answers to the questions that follow will help us to understand what you think math is all about. This will not be graded. Please tell us what you really think.

Thank you very much for your help!

1. Name _____
(Please print first and last name)
2. Teacher _____ 3. Period _____
4. Grade _____
5. School _____
6. School's City _____
7. Circle: Girl or Boy
8. How old are you? _____

___ ___ ___
1 2 3

Instructions: For each statement, circle the number that best answers the question for you. A smiley face means very true, always, the tops. A frowning face means not at all true, never true, or the worst. The middle face means neutral or in the middle. If you feel in between on some answer., choose the number in between.

SECTION 1 The math that I learn in school is :	Not True		Neutral		Very True
9. Mostly facts and procedures that must be memorized.	1	2	3	4	5
10. A way of thinking about things.	1	2	3	4	5
11. Describes the world in some way.	1	2	3	4	5
12. Related to other subjects studied in school.	1	2	3	4	5
SECTION 2					
13. In math the answer is either right or it is wrong.	1	2	3	4	5
14. Good math teachers let students figure out their own way of solving problems.	1	2	3	4	5
15. Good math teachers show students lots of ways to look at the same problem.	1	2	3	4	5
16. Good math teachers show you the exact way to answer the math problems you will be tested on.	1	2	3	4	5

SECTION 3

17. Everything about math that is important is already known by someone.	1	2	3	4	5
18. In math you can sometimes figure out new ideas by yourself.	1	2	3	4	5
19. To solve math problems you have to be taught the right procedure, or you can't do anything.	1	2	3	4	5
20. Math problems outside of math class can be solved by common sense instead of the math rules you learn in school.	1	2	3	4	5
21. The best way to do well in math is to memorize the way to solve the problems.	1	2	3	4	5
22. The best way to do well in math is to use a calculator.	1	2	3	4	5

SECTION 4

23. Some people are good at math and some aren't.	1	2	3	4	5
24. I am naturally good at math.	1	2	3	4	5
25. Girls are naturally better at math than boys.	1	2	3	4	5
26. I am good at math when I study very hard.	1	2	3	4	5
27. I get good grades when I'm not careless on my math papers.	1	2	3	4	5
28. I can get the answer, but not always the way the teacher wants.	1	2	3	4	5

29. It's important to my mother that I do well in math.	1	2	3	4	5
30. It's important to my father that I do well in math.	1	2	3	4	5

SECTION 5

31. Math is a very useful subject.	1	2	3	4	5
32. Math will be useful to me when I grow up.	1	2	3	4	5
33. In my life I will need to know more math than I know now.	1	2	3	4	5
34. Most jobs require knowledge of mathematics beyond what I know now.	1	2	3	4	5
35. Math is only important for people who want to be scientists or engineers.	1	2	3	4	5
36. My parents use math.	1	2	3	4	5

37. Tell me about your most favorite classes in school. Then tell me about your least favorite classes in school.

Most Favorite: _____ Why? _____

_____ _____

_____ _____

Least Favorite: _____ Why? _____

_____ _____

_____ _____

APPENDIX D

TEACHER INSTRUCTIONS AND CALENDAR

INSTRUCTIONS LIST

ATTITUDE SCALES

1. Scales to be given the first two or three days of class and in May.

2. The scales will take approximately five to ten minutes for students to complete. They may be given the same day as the test, but is not mandatory to do so. Administration of the questionnaire must precede the test, however. The pilot administration of both instruments took 43 minutes from start to finish.

3. Interpreting vocabulary to individual students is permissible.

4. When students are finished with the attitude scale, have them place it directly into the addressed envelope. Instruct the last student to complete the questionnaire to seal the envelope in front of the class. This is in order to assure students of anonymity of their responses.

5. If students are absent, please give them the test and questionnaire when they return in order for us to maximize our sample sizes.

CALENDAR

1. Please keep a calendar for the entire year with your target class. All activities conducted each day should be entered in the calendar. See handout sheet for instructions.

2. The calendar is to be mailed to OSU at the end of each middle school term.
   Please mail to: Dianne Erickson
   Department of Science, Math, and Computer Science
   Education
   Weniger Hall, Room 253
   Oregon State University
   Corvallis, Oregon 97331

CLASSROOM VISITS

1. The TOMTOMS staff (Maggie, Dianne, Linda B.) will visit your classes once during the first part of the year and again during the second part of the year.

2. The purpose of the visit is for OSU staff to assist TOMTOM teachers in any way requested.

3. We will call you to make arrangements ahead of time. Expect a call in the fall during your prep period at school or in the evening at home. Please have your requests for assistance in mind. For example, we could discuss the project with students, we could team teach a TOMTOMS lesson with you, or we could observe your classes for whatever purpose you determine.

4. Please make sure that your principal or administrator is informed of the visit prior to our arrival.

JOURNAL

1. Journal for the target class will give running commentary on how units and/or activities are progressing. Journal entries should include comments about teachers' perceptions of how well planned activities work and are received by students. Reflections are invited both for short term and long term objectives and goals.

2. The journal will also be used to keep a running list of TOMTOMS activities used in other than the target classes, the classes they are used in, and brief evaluations of those activities.

3. The journal is to be mailed to OSU after the end of each middle school term.

PORTFOLIO

1. Please keep a file of all activities used in the target class. This file should include copies of all worksheets and handouts.

2. The portfolio is to be mailed to OSU after the end of each middle school term.

TARGET CLASS

1. For our purposes, please select a typical class as your target class. That is, a class that will be intact throughout the year, is not at the beginning or the end of the day, has a minimum number of pull-outs, and is representative of the school population.

2. If more than one class are candidates for a target class, choose by lottery.

3. You may certainly keep data on more classes of the same type if you wish. Especially if you suspect that the class you have chosen may turn out to be idiosyncratic.

4. We suggest that you recruit your non-TOMTOMS teacher from the ranks of teachers who will teach without using alternative instructional materials, particularly TOM-TOMS materials. If there is no one in your school who fits this bill, feel free to recruit someone from a nearby, similar school. If you find more than one person who wishes act in the role of a control, ask them to collect data as well. Please indicate the situation on your returned materials.

TESTING

1. Testing should take place during the first week of class, i.e, before regular instruction begins.

2. The test should be given during one continuous class period not to exceed 45 minutes.

3. Explain to the students that we trying to find out what 6th grade students remember, but that 7th grade material is also included and that they may not know the material. Encourage them to make reasonable guesses or to try new strategies.

4. Have a filler prepared for students to work on after completion of the task. Sixth grade PSM materials worked very well for the pilot situation.

5. Interpretation of the test for students should be limited to explanation of non-math vocabulary. Do not give hints.

TROUBLE SHOOTING

1. Contact Numbers: 737-4031, Department Office
737-1821, Dianne's Office
737-1924, Linda's Office

2. Feel free to call or write about concerns, questions, or suggestions at any time during the year.

VIDEOTAPING

1. You must videotape five class sessions of the target class. You may videotape other classes if you wish, but this is not required.

2. We recommend the following schedule:
   a. Two in the fall
   b. Two in the winter
   c. One in the spring

Other permutations of this arrangement are acceptable,but try to spread the sessions out as much as possible.

3. Videotapes must be received by Dianne prior to the posttesting.

4. Practice videotaping is encouraged. It is permissible to video more than five sessions and choose the ones you like best.

5. We would like to have samples of the following:

a. One typical class session of material you have taught previously.

b. One class session where you use your own original TOMTOMS material.

c. Three class sessions in which you use new or original TOMTOMS materials. At least one should be original TOMTOMS material.

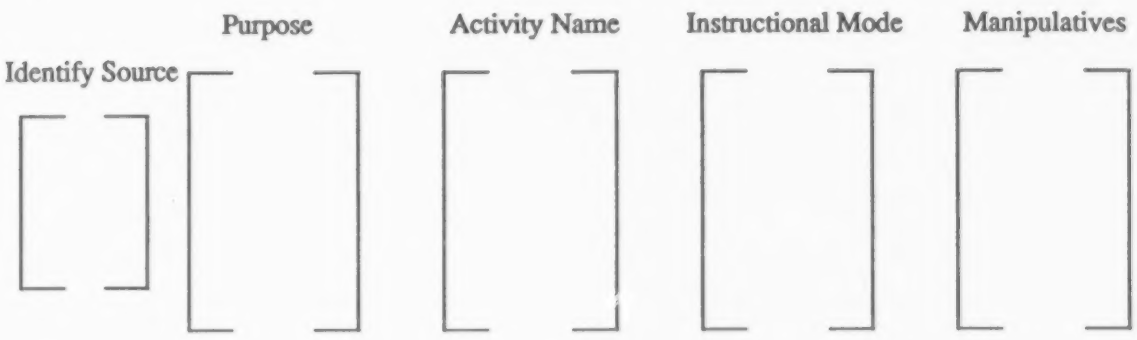
d. Designate on the videotape which session corresponds to each item. Also note starting positions of each session on the tape.

6. Videotaping may be done simply by placing the camera in the back of the room. Please have it trained on your teaching station.

TEACHER CALENDAR

FORMAT

Please enter information into the teacher calendar in the following format using the code lists provided.



Identify Source

Name	Code
From participant packet (Project 1 stuff)	*
TOMTOMS MATERIAL (Maggie, Di, Leaders...)	**
My Original Stuff	***

Purpose

Name	Code
Warm Up	WU
Check Pre-Requisite Skill	CPR
Foreshadow a Coming Development	CD
Developing a Postiive Attitude	PA
Motivation	M
Develop Understanding	DU
Practice	P
Application	A
Maintainance of Skill	MS

Recreation	R
Filler	F
Develop Problem Solving Skill	PS
Closure	C

Activity Name

When using TOMTOMS material, please include the specific name from the packet.

Instructional Mode

Name	Code
Teacher Instruction	TI
Large Group Discussion	LG
Small Group Work	SG
Individual Seatwork	I
Homework	H
Lab Discover	L
Pairs	PR
Coop Learning	CL
Project	PJ

Manipulatives

If a manipulative is used in the lesson, please make a checkmark in the last section.

If a checkmark is entered and the type of manipulative is not indicated by the handouts or by the journal entry, please enter a code below the checkmark.

Name	Code
Computers	COM
Calculator	CAL
Compasses and/or protractors	CP
Measurement Devices	MD
Algebra Tiles	AT
Base 10 Blocks	BB
Miras	MI
Pentominoes	P
Tangrams	TG
Dices, spinners, or other random number generators	RNG
Pattern Blocks	PB
Geometric Figures	GF
Other	Please Specify

APPENDIX E

TEACHER QUESTIONNAIRE

Teacher Questionnaire

Name _____

Date_____

1. If your school, principal, home address, or phone numbers have changed since last summer, please direct me to the back of the page so that I can make changes in our data base. _____

2. If your teaching certification/endorsements have changed since last summer, please list the changes here.

3. Please complete the following chart regarding your teaching assignment for this year.

Period	Class Name	Approximate Time
1		
2		
3		
4		
5		
6		
7		
8		

4. Describe how students were assigned to your target class. Include the different levels of math available for those students.

5. Describe the availability of calculators, computers, software, and manipulatives for your target class. Discuss your use of these technologies/manipulatives this year.

6. Approximately how much time did you spend each week on the following activities for the target class:

a. preparing for classes _____

b. grading homework _____

c. making and grading tests _____

d. teaching _____

e. other school responsibilities _____

Describe other responsibilities:

Please answer the following questions about your target class. (Circle the appropriate answer. Feel free to comment.)

7. How much time did you have to spend preparing alternative assignments, projects, and problem solving activities in addition to the basic course requirements?

1	2	3	4	5
None		Some		A lot

8. To what extent was it necessary to use materials in addition to your textbook to teach your class?

1	2	3	4	5
None		Some		A lot

9. How much flexibilitiy did you have in the curriculum to include additional or alternative activities?

1	2	3	4	5
None		Some		A lot

10. How much encouragement did your department give you for using course materials other than your text?

1	2	3	4	5
None		Some		A lot

11. Estimate the percent of available time that your spent in a typical week on the following activities in your target class.

a. development/maintenance of concepts/skills _____

b. applications of concepts/skills _____

c. problem solving _____

d. open-ended investigation _____

e. other _____ _____

12. What percentage of students in your class were competent at the following activities?

a. development/maintenance of concepts/skills _____

b. applications of concepts/skills _____

c. problem solving _____

d. open-ended investigation _____

e. other _____ _____

13. What percent of the avilable time in this class did students spend in:

    a. large group discussions _____

    b. cooperative small groups _____

    c. independent work _____

    d. other _____ _____

14. About how much in-class time per week did you provide for homework? _____

15. How would you categorize student use of calculators in this class? Check one.

    Free access by students _____

    Teacher determined access _____

    No calculator use _____

    Free access except on tests _____

16. Did you use computers in this class? _____

    How often? _____ For what purpose?

17. Did you teach estimation and mental math skills in this class? _____

18. Approximately how many weeks this year did you spend teaching the following:

a. Probability _____

b. Statistics _____

c. Geometry _____

d. Measurement _____

e. Algebra _____

f. Problem Solving _____

g. Numbers/Computation _____

h. Graphing, patterns, relationship _____

i. Integrated Units _____
Please describe the integrated units below:

j. Other _____
Please describe the other units below: